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Marine Casualty Investigations

Enquêtes sur les accidents maritimes

Investigation Report to the Minister pursuant to sections 542 or 545 of the Canada Shipping Act

Rapport d'investigation au Ministre conformément aux articles 542 ou 545 de la Loi sur la marine marchande du Canada

Canada

Ce rapport est aussi disponible en français

REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES ATTENDING THE STRUCTURAL DAMAGE, LISTING AND SUBSEQUENT LOSS OF DECK CARGO FROM THE CANADIAN BARGE "IRVING DOLPHIN" WHILST UNDER TOW OF THE TUG "IRVING ELM" OFF THE EAST COAST OF NOVA SCOTIA ON OCTOBER 27, 1985.

REPORT No. 433

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REPORT OF INVESTIGATION INTO THE CIRCUMSTANCES ATTENDING THE STRUCTURAL DAMAGE, LISTING AND SUBSEQUENT LOSS OF DECK CARGO FROM THE CANADIAN BARGE "IRVING DOLPHIN" WHILST UNDER TOW OF THE TUG "IRVING ELM" OFF THE EAST COAST OF NOVA SCOTIA ON OCTOBER 27, 1985.

Particulars of Vessel

Motor Vessel "IRVING ELM"

Name	"IRVING ELM"
Official Number	369826
Port of Registry	Saint John, New Brunswick
Call Sign	VC9942
Gross Tonnage	427
Net Tonnage	84
Length	32.31 m
Breadth	9.17 m
Depth	4.79 m
Draught (at time of incident)	F: 3.81 m A: 4.26 m
Type	Tug
Built	1980 Saint John, New Brunswick
Propulsion	Two, 8 cylinder, MAK 8 M 332AK diesel engines developing a total of 3500 b.h.p., driving two control- lable-pitch propellers. Engines and propeller pitch controlled from the wheel-house.
Crew	9
Classification	Lloyd's, Ice Class III

Owners	New Brunswick Publishing Company Limited Saint John, New Brunswick
Operators	Atlantic Towing Limited Saint John, New Brunswick

Navigational Equipment

Radar 1	Decca RM1914A fitted with clear scan VP ½, ranges 0.25 to 48 miles, unstabilized ship's head up.
Radar 2	Decca RM1914A fitted with clear scan VP ½, ranges 0.25 to 48 miles, unstabilized ship's head up.
Direction Finder	Lodestar III
Echo Sounder	Simrad EL.N
Loran 'C' 1	Internav LC300
Loran 'C' 2	Internav LC123
VHF Radio 1	Raytheon RAY 50A
VHF Radio 2	FMX 755
Single Side Band Radio 1	Marconi CH100
Single Side Band Radio 2	Marconi CH150
Gyro Compass	Sperry, SR 120
Gyro Compass Repeater	Sperry, at steering position
Magnetic Compass	Sestral 906ZY
Auto Pilot	Wagner, Mark IV
Chart in Use	CHS L/C 4012

Description of Vessel

The "IRVING ELM" is a steel-hulled, deep-sea tug. She is in possession of a valid Steamship Inspection Certificate,

S.I.C. 17, issued at Saint John, New Brunswick, March 15, 1985, expiry date March 14, 1986.

Non-Propelled Barge "IRVING DOLPHIN"

Name	"IRVING DOLPHIN"
Official Number	326462
Port of Registry	Saint John, New Brunswick
Gross Tonnage	1126
Net Tonnage	1117
Length O.A.	60.97 m
Breadth	15.24 m
Depth	3.96 m
Draughts (at time of departure)	F: 2.710 m A: 3.225 m M: 2.971 m
Type	Non-propelled barge
Built	1965 Saint John, New Brunswick by the Saint John Shipbuilding and Drydock Company Limited
Propulsion	Nil
Cargo	1744.85 t finished, packaged lumber
Crew	Nil
Classification	Lloyd's, 100A Oil Tanker, River and Gulf of St. Lawrence, Nova Scotia and New Brunswick coasting service
Owner	J.D. Irving Limited Saint John, New Brunswick
Managers	Atlantic Towing Limited Saint John, New Brunswick

Description of Vessel

The "IRVING DOLPHIN" is a tanker barge built for the dual purpose of transporting bulk oil products below decks or wood chips in bulk on deck. She is classed and assigned a tanker load line by Lloyd's Classification Society. The two voyages prior to and including the incident were made carrying packaged construction lumber on deck.

When carrying deck cargoes, her tanks are empty, closed and gas freed; her tanker classification and load line no longer apply and, because she is unmanned, none of the regulations made pursuant to the Canada Shipping Act apply. Consequently, she is not inspected by the Steamship Inspection Branch of the Canadian Coast Guard nor issued a Steamship Inspection Certificate. She is non-propelled, motive power being provided by an outside source, in this case a tug towing.

The "IRVING DOLPHIN" is of steel construction, having a barge type hull form with a spoon shaped bow and a raked swim ended stern. The hull is arranged with four transverse oiltight bulkheads and a longitudinal oiltight and watertight bulkhead on the vessel's centreline, extending from the bow and throughout the length of the cargo oil tanks. These bulkheads subdivide the hull into the following main compartments: forepeak which incorporates a machinery/generator-room to starboard and a cargo pump-room to port; No. 1 port and starboard cargo oil tanks; No. 2 port and starboard cargo oil tanks; No. 3 port and starboard cargo oil tanks; after peak which is void and includes a watertight space housing the wood chip discharging machinery. Steel casings erected above the deck, giving access to the wood chip discharging machinery aft and the pump-room and generator/machinery-room forward, are fitted with steel watertight doors.

When carrying timber or wood chip deck cargoes, 5 m high upright steel stanchions of 355 mm x 205 mm x 6.65 kg/m 'H' angle, are fitted into 1.7 m high deck sockets which are spaced approximately 2.44 m apart. Wooden studs 100 mm x 100 mm are slotted horizontally between the upright stanchions, forming a continuous wall approximately 5 m high, all around the deck.

Reportedly, the steel upright stanchions are secured from lifting by being tack-welded to the deck stanchion sockets.

The "walls" formed by the uprights and studs are inboard of the vessel's sides approximately 0.6 m, aft of the bow approximately 5 m and forward of the stern approximately

1.2 m, forming an open topped box approximately 5 m high, 14 m wide and 55 m long. (See sketch number 1.)

Manholes, giving access to each cargo oil tank, are situated in the deck stringer plate between uprights, outboard of the cargo "box" and adjacent to the vessel's side. These manholes measure approximately 450 mm x 330 mm. They are rectangular in shape and each one is closed by means of a cover consisting of a rectangular steel plate secured to the underside of a coaming in the deck by two steel strong-backs which span the opening and pass across the top of the coaming. A rubber gasket fitted to the cover prevents direct contact between coaming and cover and provides watertightness. (See sketch number 2.)

NOTE: 1. All times in this report are expressed in Atlantic Daylight Saving Time (UTC minus 3 hours) until midnight, Saturday, October 26, when clocks were retarded 1 hour to Atlantic Standard Time (UTC minus 4 hours).

2. A Glossary of terms and abbreviations can be found following the Findings in this report.

Background

The barge "IRVING DOLPHIN", loaded with a deck cargo of approximately 1745 tonnes (1 873 333 nominal board feet) of finished, packaged construction lumber, departed Saint John, New Brunswick on October 23, 1985 in tow of the tug "IRVING ELM" bound for Long Pond Manuels, Newfoundland.

On October 27, when in position 45°54'N, 59°28'W, a list to port developed and part of the cargo, approximately 1645 t, was lost overboard.

The tug and tow then diverted to Louisbourg, Nova Scotia, where temporary repairs were effected to the barge prior to both vessels returning to Saint John, New Brunswick.

No injuries or oil pollution occurred as a result of this casualty and the loss of cargo was estimated to be approximately one million dollars.

Narrative

The barge "IRVING DOLPHIN" loaded a deck cargo of 1 873 333 nominal board feet (1745 t approximately) of

finished, packaged construction lumber at New Brunswick. The initial loading, consisting of 565 packages, took place at Barker Point on the Saint John River near Fredericton. Draught restrictions in the river required the balance of 257 packages to be loaded at a deeper water berth; consequently, the partly loaded barge was towed down river to Saint John where loading was completed on the afternoon of October 23.

The completed load gave the barge draughts of 2.710 m forward and 3.225 m aft; this gave a freeboard of approximately 1 m amidships. The barge was trimmed 0.515 m by the stern, a trim which would tend to be reduced whilst under tow by the downward pull due to the weight and catenary of the tow rope and the strain from the tug whilst towing. This reduction in trim would have been minimal. She was upright with no discernible list.

The cargo consisted of packages of various species and sizes of lumber, each package measuring approximately 1 m high by 1.2 m wide; lengths varied from 2.43 m to 4.87 m.

There were four full tiers of cargo topped by two part tiers giving a total height of 6.35 m, the fifth tier reaching 0.25 m above the cargo box walls, the sixth tier 1.25 m above the walls. The cargo was stowed within and extended above the cargo "box". (See sketch number 3.)

The cargo was secured inside the "box" by shorings consisting of 100 mm square baulks of timber. Lashings consisting of 20 mm diameter wire, complete with chain and bottlescrew tensioning devices, were stretched between port and starboard uprights and over the tops of the fifth and sixth tiers of the packaged cargo.

On completion of loading, a surveyor from a private marine surveying company undertook a survey of the cargo securing arrangements and also a survey of the towing arrangements. A certificate was issued in both respects stating that, in his opinion, the vessel was fit to proceed to sea. She was not inspected by a Canadian Coast Guard Steamship Inspector with respect to the Timber Deck Cargo Regulations, nor was she required to be.

The first mate of the "IRVING ELM" inspected the cargo securing arrangements and ensured that watertight doors to the generator-room, pump-room and chip blower-room were secured; the cargo oil tank access manholes and covers were not inspected by the first mate. However, the issuing by the surveyor of the certificate covering the towing arrangement would indicate that the manholes and the covers would have been inspected by him.

The "IRVING ELM" departed Pier 12, Saint John, with the "IRVING DOLPHIN" in tow at 2245 on October 23. On reaching open water, the tow was lengthened to the usual deep-sea towing mode of approximately 2.5 cables (457 m).

The weather conditions on departure were: southerly winds at 10 to 15 knots, slight sea, low swell. The weather remained good for all of October 24 and 25 as the tug and tow proceeded through the Bay of Fundy and then north-east along the coast of Nova Scotia, the two vessels rolling and pitching easily, average speed approximately 9 knots.

Weather forecasts issued by Environment Canada at 1600 and 2030 on October 25 indicated a change in wind direction from SW to NW and an increase in velocity to 20-30 knots for the morning of October 26. On the basis of this information, together with visual observations of deteriorating weather, the tug master decided at 2030, October 25, to divert the tug and tow to Gabarus Bay, Nova Scotia, to await improved weather conditions.

At 0445, on October 26, the tug anchored in Gabarus Bay, both vessels riding to the tug's anchor. The wind veered and increased to north-west 30-40 knots until noon, October 26, then steadily diminished. On the basis of other forecasts indicating that the wind would back to westerly 15 to 20 knots, the tug master decided to continue the voyage and the anchor was weighed at 1800. The weather at 2000 was wind westerly 20 knots, the seas from the west at heights of approximately 2 m. The course on leaving Gabarus Bay was maintained at 084° True, and the speed gradually built up to approximate 9 knots.

Visual observations of the barge from the tug whilst at Gabarus Bay had indicated that all was well; she (the barge) rode upright and at the same trim as that noted on departure from Saint John, New Brunswick.

At 2155 after completing some 24 miles from the anchorage and in a position approximately 10.5 miles south-east of Scaterie Island, it became obvious that something was wrong with the tow; the barge kept sheering to port.

Sunset and the end of Civil Twilight had passed at 1700; however, radar observations of the barge and the sighting of her starboard side light had indicated the sheering.

Speed was reduced and course altered toward the south of Scaterie Island, 290° True, to head into the seas and to seek calmer water in the lee of the land. At 0200, October 27, the "IRVING ELM" started to shorten tow. At 0230, she

stopped and the crew made observations of the barge from the tug using her searchlight. The "IRVING DOLPHIN" was seen to be listing some 25° to 30° to port and rolling to port a further 20°, the combined effect of the list and roll being approximately 50° (to port). Most of her cargo had been lost and considerable damage had been occasioned to the port "wall" of the cargo "box". Sydney Coast Guard Radio was advised and the tug and tow proceeded to take shelter in the lee of Cape Breton Island. At 0430, the vessel's owners at Saint John, New Brunswick, directed them to proceed to Louisbourg, Nova Scotia. At 0830, both vessels secured at Louisbourg.

On arrival, the "IRVING DOLPHIN" was observed to be listing 28° to port, her port side immersed and seawater covered the port side of her deck to within approximately 2 m of her centreline. The services of a diver determined that the manhole cover to number 3 port cargo oil tank was missing (later found at the bottom of the tank) and the deck stringer plates in way of the other two port side tanks were fractured in the areas where upright sockets had broken from the deck; consequently, all three port side tanks were flooded.

A manhole cover from one of the starboard cargo oil tanks was removed and fitted to number 3 port tank by a diver; the tank was then pumped out by shore pumps via a hole cut in the deck plating close to the centreline. This righted the barge sufficiently to raise the port side deck edge above water which then enabled the two other port tanks to be pumped dry. The barge was returned to the upright at approximately 1300, October 27.

Structural damage had been confined to the barge's port side deck stringer plate. Temporary repairs were made which enabled the two vessels to return to Saint John, New Brunswick.

Cargo Lost

Approximately 1645 t (1 765 978 nominal board feet).

Cargo Remaining

Approximately 100 t (107 354 nominal board feet).

Damage Incurred to "IRVING DOLPHIN"

Starboard Side

3 "H" angle uprights buckled inboard.

One bay of 100 mm x 100 mm wcoden studs missing.

Port Side

6 "H" angle upright deck stanchions and sockets missing.

16 "H" angle upright deck stanchions buckled outboard.

One cargo hose boom stanchion post missing.

Deck stringer plate buckled and fractured in way of six missing upright sockets.

Ventilator to number 2 port tank missing.

Deck fire line distorted.

Number 3 port cargo oil tank manhole cover strongbacks broken and manhole cover found inside the tank.

All 100 mm x 100 mm studs forming the wall between upright stanchions missing.

Deck

Approximately two-thirds of the wooden deck sheathing missing.

16 cargo securing wires used between uprights broken and partially missing.

Damage Incurred to the "IRVING ELM"

Nil.

Analysis

1. The "IRVING DOLPHIN" was built in 1965 as an unmanned barge and, when carrying non-oil cargoes between Canadian ports, is not required by the Canada Shipping Act to comply with any intact stability requirements or have a load line assigned. However, safe operating practice and financial prudence would indicate that operation of the barge should follow good practice and at least be guided by the most appropriate modern stability standards. Canadian Coast Guard Stability Standard, STAB 8, for Unmanned Cargo Barges, gives appropriate criteria for intact transverse stability.

   Calculations show that, provided the timber deck cargo remained compactly stowed and secured, the intact transverse stability of the "IRVING DOLPHIN" was

adequate for the voyage. The GM upon departure was 3 m and, allowing for 10% seawater absorption by the deck cargo, the arrival GM would have been 2.64 m.

2. The range of stability of the barge upon departure, with the deck cargo compactly stowed and secured, was approximately 73° and, allowing for 10% seawater absorption by the timber deck cargo, would have been 69° upon arrival. The areas under the curves of statical stability up to the angle of the maximum righting lever (GZ) were 0.444 m radians and 0.368 m radians, respectively, both clearly in excess of the appropriate standard of 0.08 m radians indicated by STAB 8. (See Annex I.)

3. The mean draught, assuming an even keel when under tow, was approximately 2.971 m. This gave the barge a freeboard at amidships of 0.989 m which would vary as the vessel was subjected to the usual motions experienced in a seaway, namely:

Rolling - motion about the longitudinal axis

Pitching - motion about the transverse axis

Yawing - motion about the vertical axis

Heaving - vertical bodily motion

Sway - lateral, or side to side, motion

Surge - longitudinal, or fore and aft motion

4. The beam of the barge is 15.24 m; the freeboard amidships was 0.989 m. The angle of heel to which the barge would have to roll <u>in still water</u> in order to immerse her deck edge is calculated at about 7.5°. Other motions, particularly pitch and heave, would, at times, reduce the freeboard causing the deck edge to immerse at lesser angles of heel.

5. On external examination, after the casualty, the barge was observed to be rolling some 20° to port. Due to the down flooding of the three port cargo oil tanks and loss of cargo, etc., her stability characteristics had by then completely changed. However, assuming a roll of 10° starboard to 10° port when intact with the cargo compactly stowed and the barge under tow just prior to the casualty, then <u>in still water</u> her deck edges at amidships would have been immersed approximately 0.35 m with each roll.

6. The seas were estimated to be running from the west at a height of approximately 2 m, wind speed some 20 knots, the vessel's course was 084° True (East by North), speed 9 knots. In a seaway, as the seas washed up against her stern, her port and starboard quarter and the cargo box were subject to frequent irregular submersion by up to 2 m - 3 m due to the combined effect of the barge's aft trim and her aft freeboard as the vessel rolled in a seaway with wave heights of from 1 m to 2 m.

7. The number 3 port cargo oil tank manhole cover was found at the bottom of the tank, its two strongbacks sheared at their junctures with the central part through which the retaining and tightening bolts project. (See photographs and sketch number 2.)

8. The other two port cargo oil tanks were found to be fractured at the deck stringer plate in way of the uprights which had broken from the deck; these tanks were also flooded.

9. The broken strongbacks of number 3 port cargo oil tank manhole cover were not made available by the barge owner and, therefore, could not be subjected to detailed examinations or testing for inherent faults, fractures, weld defects or metal fatigue.

10. It is not the usual <u>specific</u> practice for the crew of the "IRVING ELM" to ensure that barge manhole covers are in place and secured prior to departure. Their main interest is in accesses that are regularly used such as the pump-room, generator-room and chip blower-room watertight doors. However, it is likely that the vessel departed Saint John with the manhole cover of number 3 port cargo oil tank in place, because its situation outboard of the uprights forming the cargo "box" requires that crewmembers walk over the manhole whilst attending to pre-departure duties such as mooring lines, etc. The absence of the manhole cover would most likely have been noticed during these procedures but such an absence was not observed.

    The barge carries six covers for the total number of six manholes; there are no spares. Number 3 port cargo oil tank manhole cover was found in the tank. The covers are of a type that, unless carefully tilted prior to being lifted, they cannot be removed from the tanks. At the time of visual inspection during investigations, the manhole had been immersed in seawater for some 60 hours and, although the fractured strongbacks were rusted, "light" or "white" spots did indicate a recent fracture.

All of the above indicates that the manhole cover found in number 3 port tank was not an old one left in the tank, but was the one in use which carried away during the voyage.

11. The manholes had last been visually inspected and found satisfactory by a Classification Society Surveyor during a special tanker survey carried out on May 20 and 24, 1985. The tanks were again opened for a continuing part of the special survey on October 4, 1985 and all manhole covers replaced and hand tightened by means of a wrench, as is the usual practice.

12. Reportedly, the manhole covers had never been renewed during the lifetime of the barge (20 years) and, apart from surveys, were only removed and replaced when changing roles from tanker to dry cargo carrier and vice versa.

13. Whilst visual examination of the barge was made from the tug when at anchor in Gabarus Bay, the barge was not boarded and physically inspected.

14. She departed from Gabarus Bay with a following sea of approximately 2 m and following westerly winds of 20 knots. The position at which the tug first became aware of problems with the tow was some 10 miles to the south-east of Scaterie Island (see chart No. L/C 4001). The wind had been blowing from the north-west at up to 40 knots during October 26, diminishing and backing to westerly during the afternoon.

    The north-west wind of 40 knots would cause the build-up of a considerable north-westerly swell throughout the Cabot Strait, which would not be experienced by the tug and tow until clear of the lee of Scaterie Island, such was their position when the incident was first noticed. A swell will persist after the winds which caused it diminish or change direction and, in this case, would cause the tug and tow to roll considerably when they encountered it. (See chart number L/C 4001.)

15. The repeated immersing of the port after deck edge to depths of 2 m to 3 m (at a towed speed of 9 knots), together with the stresses placed upon the "wall" of the cargo "box" by the seas (as they swept aboard when the barge rolled) and the possible movement of cargo inside the "box" would cause stresses to be transmitted by the upright deck stanchions and sockets through the deck and so to the strongbacks securing the manhole covers. A failure of the strongbacks would cause the cover to fall

into the tank, and the manhole to be open to the sea.

16. Ingress of seawater to number 3 port cargo oil tank would cause the barge to assume a permanent list to port and to trim by the stern which would cause the open manhole to immerse deeper and for longer periods with each successive roll. As the tank filled, the port list became greater until the forces acting upon the cargo box "wall", due to the weight of cargo and the counteraction of the vessel's retained stability attempting to right her, became too great and the port wall and securing arrangements carried away, discharging the cargo.

    The port side deck stringer plate fractured as the upright sockets broke away with subsequent down flooding of numbers 1 and 2 port cargo oil tanks.

17. The barge was unmanned; consequently, the crew of the tug were not aware of the situation until the mishap had progressed to a very large degree, particularly as it was nightfall and with the tow at 0.25 mile astern.

18. The manhole covers to the cargo oil tanks are of a type designed to resist fluid pressure from inside the tanks when in the tanker mode and the barge is partly loaded. The covers overlap the underside of the manhole coamings and two strongbacks secure them across the top of the coamings. The strongbacks are exposed and susceptible to damage at the deck level but are outside the cargo box and clear of movable weights; there is no evidence of damage caused to them prior to departure from Saint John, New Brunswick. On inspection after the casualty, all other manhole covers, a total of five in all, appeared to be satisfactory without obvious defect, to visual examination 'in situ'.

19. The cargo was stowed to a height of 6.35 m above number 3 port cargo oil tank, 1.25 m above the "walls". There is no evidence that the securing wires across the top of this cargo first carried away allowing cargo to fall onto the manhole cover or strongbacks during the barge's passage from Gabarus Bay. The securing wires stretched between uprights and over the top tier of the timber cargo, although broken, appeared to have been in good condition when they were inspected on the barge's arrival at Louisbourg.

20. As the barge was unmanned, it was not possible to establish the sequence of events as the casualty unfolded. However, consideration was given to the

following:

a) The weight on the upright, caused by the movement of cargo, factured the deck. However as the down flooding was, apparently, relatively sudden this hypothesis has been discounted.

b) That a package of lumber became loose and fell, breaking the strongbacks, thus downflooding the tank. However such an event is most likely during a heavy port roll and in this case it is thought that the package would have been projected clear. The manhole was well protected being sited close in to the cargo box sides.

c) That the movement of the uprights and box flexed the deck causing an eventual fracture of the strongbacks, which may have been already weakened by damage during the loading process, or other occasion.

21. As the "IRVING DOLPHIN", was an unmanned barge, she was not required to comply with either the "Timber Cargo Regulations" or the "Canadian Code of Safe Practice for Ships Carrying Timber Deck Cargoes" but within practicable limits, the barge should have been guided by these practices.

Investigation revealed that:

a) The deck stringer plate fractured in way of the upright sockets resulting in loss of watertight integrity contrary to the intent of Section 2.5 of the Code.

b) The cargo lashings were secured to the pad eyes on top of the uprights and did not extend to deck level.

c) There were no athwartship taut lashings between the after port and starboard uprights (where the cargo extended above the box) to give additional strength to the uprights.

d) The uprights were reportedly tack-welded to the sockets to prevent them from lifting. Continuous repetition of this procedure would lead to localized weakening of the uprights in way of the socket tops.

(For excerpts of this Code see Annex II.)

22. The "IRVING DOLPHIN", by nature of its age and service, is not required by the Canada Shipping Act to comply with any intact stability requirements when carrying non-oil cargoes, neither is she required to be assigned

a load line. However, should stability criteria be applied, then that contained in STAB 8 (Unmanned Cargo Barges) is the most appropriate. (See Annex I.)

Early in 1985, when the "IRVING DOLPHIN" was about to begin her new role of "construction lumber transporter", the owners requested a shipbuilding company to prepare a set of stability data and load conditions for that role, which they produced later in 1985.

Although stability was not considered a factor in the casualty, the following is noteworthy:

a) The stability characteristics of the timber cargo loading conditions which were prepared at the owner's request, were related to the requirements of STAB 6 (Standard for Intact Stability of Non-Passenger Ships and Passenger Ships Carrying Not More Than 12 Passengers), instead of the more appropriate STAB 8 (interim), (Standard for the Intact Stability of Unmanned Cargo Barges).

b) The lightship weight, longitudinal centre of gravity (LCG) and vertical centre of gravity (VCG), were derived from an inclining experiment carried out aboard a similar vessel, the "IRVING SHARK", during October 1981. This experiment was conducted while the "IRVING SHARK" was in the "tanker" mode; i.e., steel upright deck stanchions, wooden deck sheathing, dunnage or securing lines were not included, a total of approximately 71 t at varying heights above the keel.

c) The cross curves of stability (KN curves) did not include an augment due to the deck cargo volume which gave an additional freeboard from the deck to the top of the cargo; consequently, the ranges of stability shown in the consultant's report were for the hull form only.

d) The actual weight of cargo, when calculated by subtracting the "timber cargo lightship weight" from the displaced weight in water at relative density 1009 (specific gravity 1.009), produces a figure of 2.60 lb per footboard measure (FBM). The weight of timber indicated in the data is 2.11 lb per footboard measure (FBM). This difference in weight was attributable to 2.11 lb being the average weight of seasoned lumber whereas the timber loaded was recently prepared and relatively "green".

e) The cargo was considered to be homogeneous and

compactly stowed with no allowance for dunnage and broken stowage.

f) The use of the term "nominal board foot" by the lumber industry is confusing unless it is remembered that the term is used to describe the original dimensions of the product and approximately 30% must be subtracted to arrive at the actual size of prepared lumber.

g) A preliminary trim and stability booklet dated October 1981, which was supplied by the vessel's operators to the consultants to assist them when compiling the timber deck cargo loading conditions, included an inaccurate lightship LCG location. A similar but revised booklet (also dated October 1981) was approved by CSI April 21, 1982, and incorporated a report of a lightship weight verification carried out March 26, 1982, in which the correct oil cargo operational lightship weight, VCG and LCG were derived. These approved data were not used by the consultants and consequently the timber cargo loading conditions they prepared did not truly reflect the vessel's stability characteristics. The vessel's actual transverse stability (because of the deck cargo volume augment), was significantly better than the consultants' conditions showed, and the after trim was slightly increased.

23. The naval architect assigned by the marine consultants to prepare the "IRVING DOLPHIN" stability data and load conditions holds a B.Sc. in Naval Architecture and Marine Engineering and had been employed by them for approximately 9 months; her previous occupation was as a student.

24. The cargo surveyor from the private company, who undertook the surveys of the securing arrangements and the towing arrangements prior to sailing, did not produce a detailed account of the securing of the deck cargo, neither could he produce photographs. The photographs of loaded cargo which are contained in this report are of a previous load surveyed by him which is reported to be similar. He purports to hold a Canadian Chief Engineer Certificate (Steam) and a Panamanian Master's Foreign Going Certificate and to have two years experience as a Master at sea and six years as a shore based marine surveyor, the last year as vice president of the company and Senior Marine Surveyor, Eng.

Marine qualifications are not a statutory requirement for a private surveyor; however, enquiries of Transport

Canada's records show that there is no record of him having been issued a Canadian certificate. Enquiries of the Panamanian Government indicate that there is no record of him having been issued a Panamanian certificate.

25. The master of the "IRVING ELM" holds a Canadian Master's Certificate of Competency, Home Trade, Steamships under 350 tons, or a tug. He has 40 years seafaring experience and has been a tug master for 15 years, the last five as master "IRVING ELM".

26. The mate of the "IRVING ELM" holds an ON II certificate. He has 10 years seafaring experience, the last six with Atlantic Towing. He has been mate for three years, the last eight months on the "IRVING ELM".

26. Approximately 1000 board feet (305 m) of the cargo was salvaged by offshore supply vessels and the remainder was predicted by the Ocean Circulation Division of the Bedford Institute of Oceanography to drift far out into the North Atlantic and become very widely dispersed.

Findings

The "IRVING DOLPHIN" sustained structural damage followed by down flooding which impaired her stability causing the partial loss of her deck cargo. The precise causes for the the structural damage are not known, however, it would appear that the following are the most likely:

- some lashings between the uprights on the after part of the barge lead upwards over the top tier of cargo, and diagonally across the cargo box, thereby being ineffective as cross lashings to the tops of the uprights. These particular uprights were thus poorly supported;

- the barge's motion in the seaway caused movement of the upright steel stanchions and wooden studs forming the cargo box walls. Stresses, caused by this movement, together with the movement of cargo within the box, were transmitted through the deck plating to the manholes causing the strongbacks of number 3 port cargo oil tank cover to fracture and the cover to fall into the tank;

- the then open tank allowed down flooding of seawater into the port tank and a port list and additional stern trim developed;

- the combination of list and motion in the seaway produced stresses too great for the cargo box to

withstand and some of the uprights failed, commencing the loss of the cargo;

- movement of the cargo box upright stanchions and the subsequent breaking of the stanchion sockets from the deck caused the deck stringer plate to fracture in way of the other affected tanks; compounding the down flooding and port list; and

- the specific nature of the failure of the manhole cover strongbacks could not be determined because the owner would not make them available for detailed examination.

Other Findings

- weather was a factor in the casualty, particularly the residual wave conditions from the previous storm; and

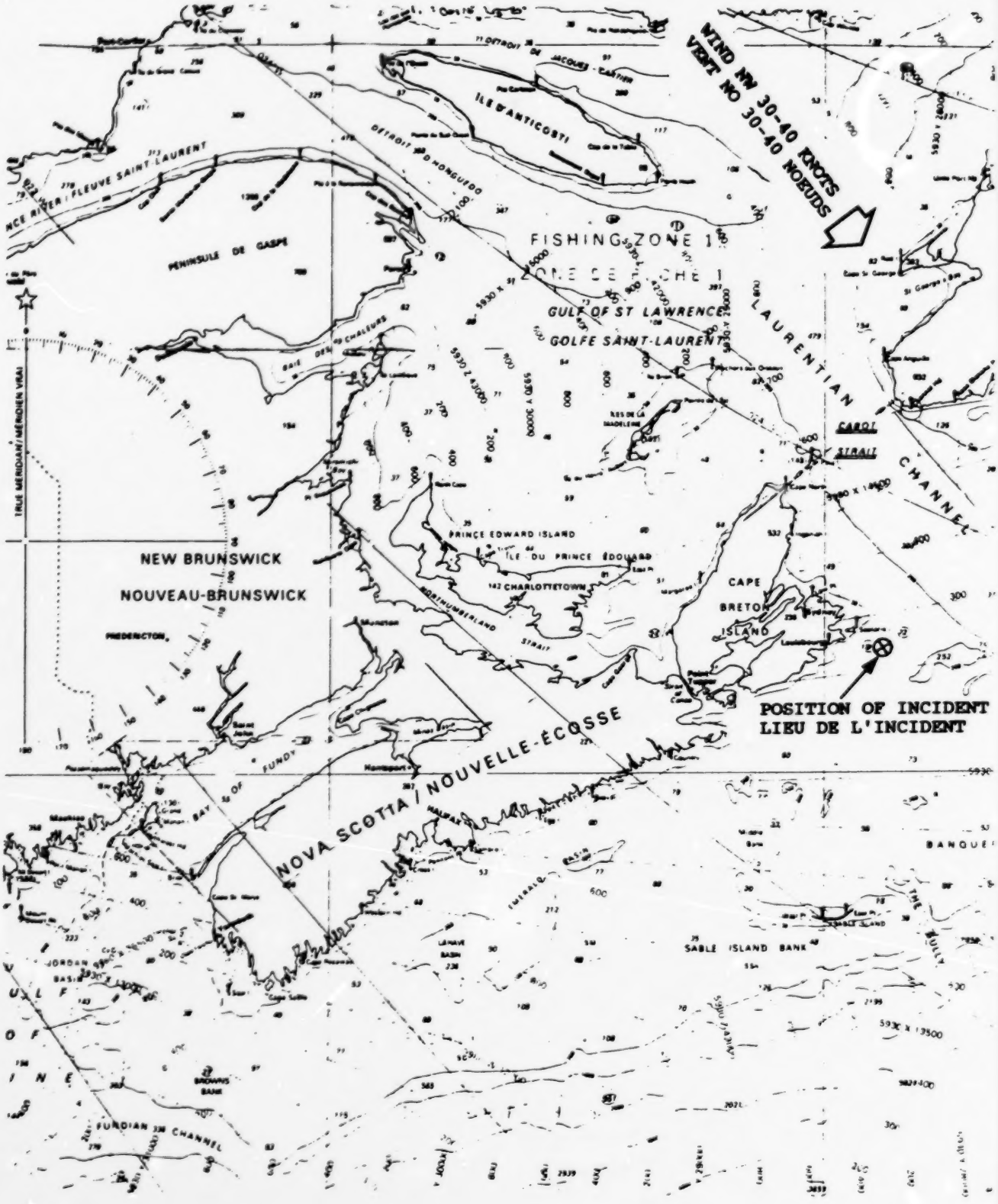
- packaged construction lumber is inherently "flexible" and invariably leaves broken stowage. The securing on the "IRVING DOLPHIN" relied mainly on "chocking" and the strength of the upright steel stanchions forming the cargo "box"; because of the "flexibility" the "chocking" failed causing the cargo to move, compounding the problems aboard the barge.

OTTAWA, ONTARIO
SEPTEMBER, 1986.

Glossary

Backing	Term used to describe a change in wind direction from right to left when facing the wind.
Broken stowage	The space remaining in a cargo compartment which is not actually occupied by cargo stowed in that compartment.
Catenary	Curve formed in the tow rope due to the weight of the rope.
Civil Twilight	The period of incomplete darkness following sunset.
Deck Stringer Plate	Deck plate at the outboard edge of the deck, adjacent to the ship's side.
Dunnage	Any material used for the protection of cargo from damage due to chafing, crushing, etc., in this case, all dunnage was wooden.
Foot Board Measure	A measure of the actual volume of finished lumber; One FBM = 12" x 12" x 1".
GM	(Metacentric Height) is the vertical distance between the centre of gravity and the transverse metacentre, and is a measure of the vessel's ability to return to the upright from small angles of heel.
GZ	(Righting Lever) is the horizontal distance between the vessel's centre of gravity and the centre of buoyancy of the heeled vessel, and is a measure of the vessel's ability to return to the upright from large angles of heel.
List	Angle of heel from the upright caused by uneven transverse distribution of weight or hull damage.
Nominal Board Foot	A measure used by the lumber industry to indicate the quantity of lumber used to provide the finished product and is approximately 30% in excess of the actual Foot Board Measure.

Range of Stability	Maximum angle to which a vessel can roll, to either side, and then return to the upright. A roll beyond the Range of Stability causes capsizing.
Spoon bow	A bow with full rounded sections, has a general resemblance to the convex bowl of a spoon.
Swim ended	Blunt, overhanging.
UTC	Coordinated Universal Time
Veering	Term used to describe a change in wind direction from left to right when facing the wind.

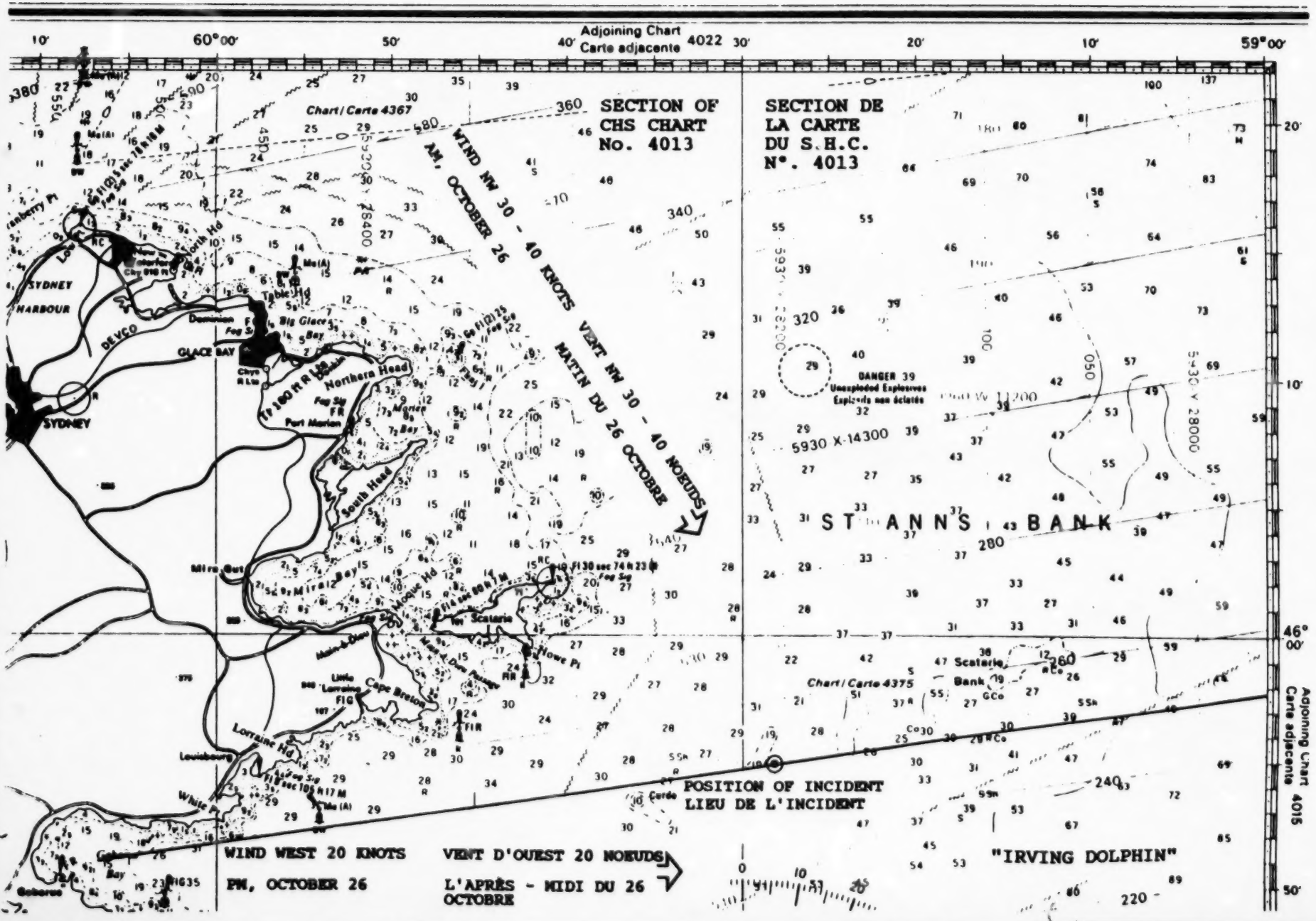


ALL POSITIONS AND TRACKS ARE APPROXIMATE

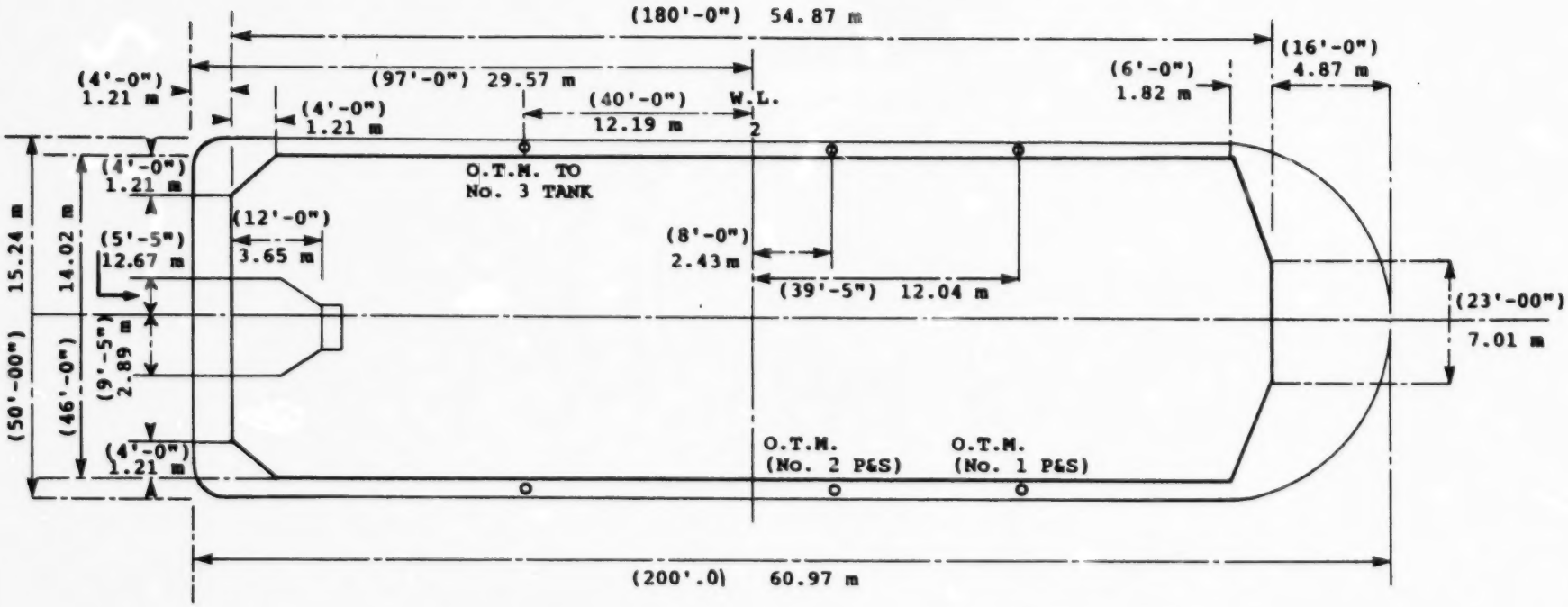
TOUS LES POINTS ET LES SILLAGES SONT APPROXIMATIFS

REDUCED SECTION OF CHS CHART No. L/C 4001

SECTION RÉDUITE DE LA CARTE DU SHC N°: L/C 4001


Adjoining Chart
Carte adjacente 4022
60°00'
59°00'
SECTION OF CHS CHART No. 4013
SECTION DE LA CARTE DU S.H.C. N°. 4013
Chart/Carte 4367
Chart/Carte 4375
WIND NW 30 - 40 KNOTS AM, OCTOBER 26
VENT NW 30 - 40 NOEUDS MATIN DU 26 OCTOBRE
SYDNEY HARBOUR
SYDNEY
DEVCO
GLACE BAY
Northern Head
South Head
Port Morien
Mira Gut
Mira Bay
Mosque Hd
Scatarie
Scatarie Bank
Howe Pt
Main-à-Dieu
Main-à-Dieu Passage
Little Lorraine
Cape Breton
Lorraine Hd
Louisbourg
White Pt
Gabarus
Gabarus Bay
ST ANN'S BANK
DANGER 39
Unexploded Explosives
Explosifs non éclatés
5930 X-14300
5930 X 28000
POSITION OF INCIDENT
LIEU DE L'INCIDENT
WIND WEST 20 KNOTS
PM, OCTOBER 26
VENT D'OUEST 20 NOEUDS
L'APRÈS - MIDI DU 26 OCTOBRE
"IRVING DOLPHIN"
Adjoining Chart
Carte adjacente 4015
46° 00'
50'

SKETCH NO. 1 CROQUIS N°. 1



PLAN VIEW OF MAIN DECK PERSPECTIVE DU PONT PRINCIPAL

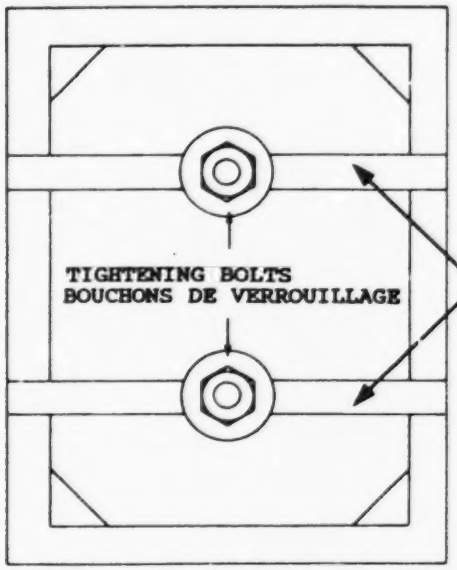
NOT TO SCALE PAS À L'ÉCHELLE

SKETCHED OUTLINE OF "IRVING DOLPHIN" WITH CARGO BOX AND DIMENSIONS

CROQUIS DU PROFIL DE LA SOUTE À MARCHANDISE DU "IRVING DOLPHIN" AVEC SES DIMENSIONS

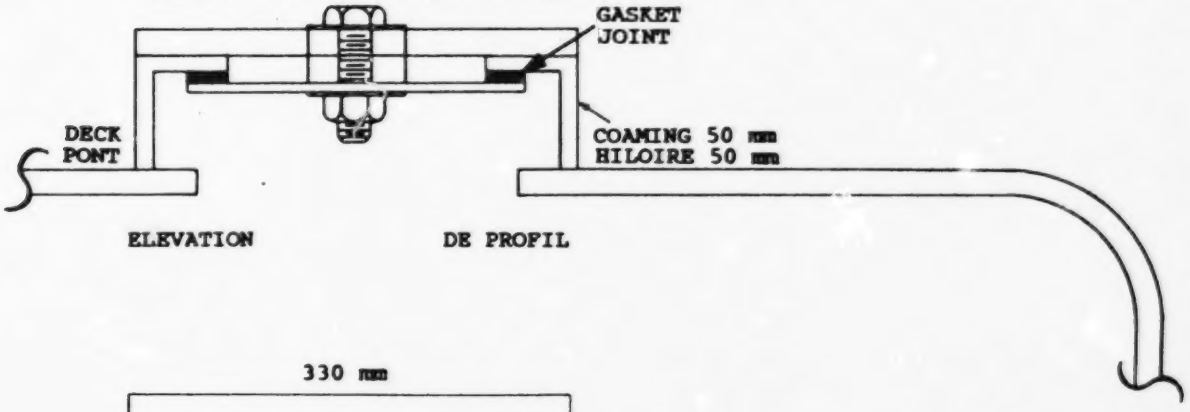
SKETCH No. 2
"IRVING DOLPHIN", MANHOLE AND COVER

CROQUIS No. 2
"IRVING DOLPHIN" TROU D'HOMME ET BOUCHON

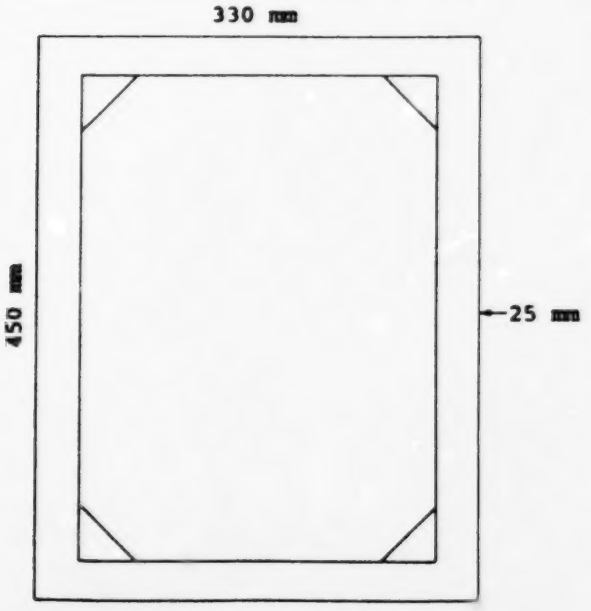


MANHOLE COVER BOUCHON DE TROU D'HOMME

MANHOLE SECURED
ÉTRIERS DE TROU D'HOMME BOULONNÉS



ELEVATION DE PROFIL

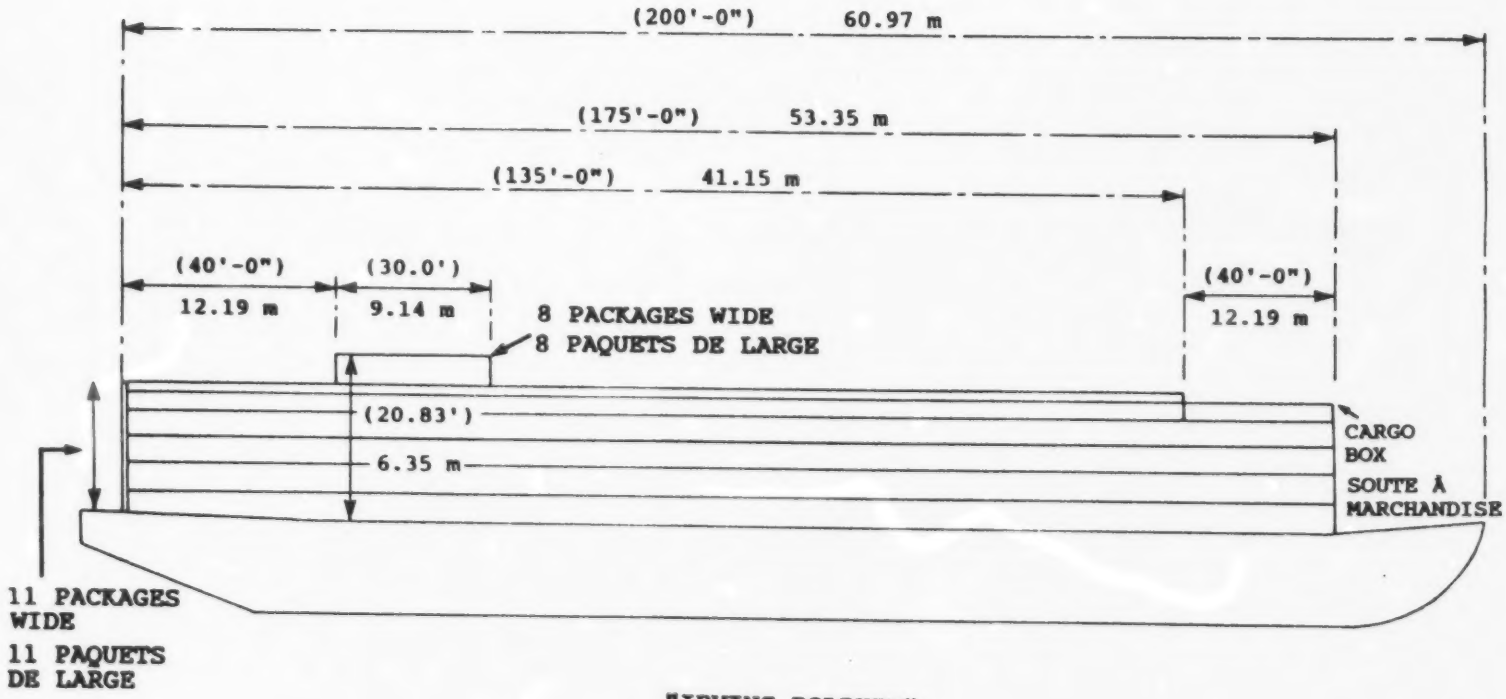


MANHOLE TROU D'HOMME

NOT TO SCALE
SEE PHOTOGRAPHS

PAS DRESSÉ À L'ÉCHELLE
VOIR PHOTOGRAPHIES

SKETCH No. 3 CROQUIS No. 3



"IRVING DOLPHIN"

REPORTED CARGO DISTRIBUTION

RÉPARTITION DE LA MARCHANDISE TELLE QUE RAPPORTÉE

ANNEX I

INTERIM STANDARD : STAB. 8

STANDARD FOR THE INTACT STABILITY OF UNMANNED CARGO BARGES

(1) The provisions of this standard are applicable to unmanned cargo barges that:

(a) are required by standard Load 2 to be assigned loadlines; and

(b) are constructed after 1 September 1977

(2) This standard does not apply to Crane, Derrick or Hopper Barges.

(3) Except where otherwise exempted by the Board, the owner of a new barge shall:

(a) arrange to have an inclining experiment carried out in the presence of and to the satisfaction of a marine surveyor;

(b) submit to the Board the developed stability data for the operating conditions of the barge, including the light, loaded and worst operating conditions; and

(c) include in the stability submission, the basic data required by section 2 of standard STAB. 2.

(4) Except where otherwise provided in Section 5 of this standard, the intact transverse stability of the barge shall be based upon a minimum area under the GZ curve up to the angle of maximum GZ, or to the angle of downflooding if this be less, of not less than 0.08 metre radians.

(5) Where the vertical centre of gravity of the cargo is below the deck at side, the required transverse stability may be determined in terms of the metacentric height in metres. The initial metacentric height at any draft must not be less than that given by the following formula:

$$GM = \frac{kB}{f_e}$$

where $k = .15$

B = Beam in metres

f_e = Effective freeboard $(f + f_a)$ in metres, where

f = freeboard to the deck at side in metres;

f_a = additional freeboard allowance for barges having a structural watertight trunk.

$$f_a = 1.25 \frac{h\ell}{L} \left(\frac{2b}{B} - 1\right) \text{ or } h, \text{ whichever is less.}$$

ℓ = length of trunk in metres
L = overall length of barge in metres
b = breadth of trunk in metres
h = trunk height at side in metres

(6) The intact longitudinal stability of the barge is to be determined in terms of the minimum longitudinal metacentric height (GM_L) within the range of operating drafts and is not to be less than that given by the following formula:

$$GM_L = \frac{.02\ L^2}{d} \text{ metres}$$

where L = overall length of barge in metres
d = draft in metres.

ANNEX II

CODE OF SAFE PRACTICE FOR SHIPS CARRYING TIMBER DECK CARGOES

Section 2 - STOWAGE - GENERAL

2.1 Openings in the weather deck on which cargo is stowed should be securely closed and battened down. Ventilators and air pipes should be effectively protected from damage by cargo and the check valves in air pipes should be examined to ascertain that they or similar devices are effective against the entry of sea water.

2.5 Uprights, when required by the nature or height of the timber, should be of adequate strength which should not exceed the strength of the bulwark and the spacing should be suitable for the length and character of timber carried, but should not exceed 3 metres (9.8 feet). Strong angles or metal sockets or equally efficient means should be provided for securing the uprights. Where suitable, permanent ship's structure may be used as uprights.

2.5.1 The uprights should be of such height as to extend above the outboard top edge of the cargo.

2.5.2 They should preferably be fitted with a locking pin or other arrangement to retain the upright in its housing.

2.5.5 Each port and starboard pair of uprights should be linked by athwartship lashings, set up taut joining each pair as near to the top level of the cargo as possible to give additional strength to these uprights. The lashings should be in accordance with the recommendations of Section 4.

Section 3 - LASHINGS - GENERAL

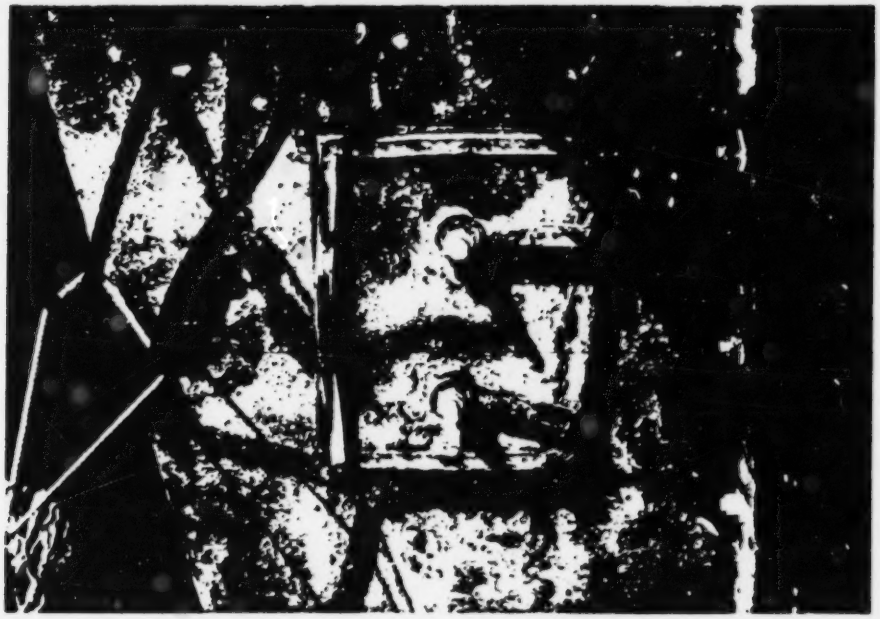
3.1 At the completion of loading, a system of overall independent athwartship lashings to the specification as given in Section 4 should be set up throughout the entire length of a deck stow. The spacing between adjacent lashings should be in accordance with Sub-Sections 5.2 and 5.3 such that each lashing should pass over the cargo and be shackled to eye plates positioned in the sheer strake, deck stringer plate or other strengthened point. Stanchions and brackets or other such points of insufficient strength should not be used for the securing of lashings.

"IRVING DOLPHIN" Photograph of previous load. Reported similar stow on this voyage.

"IRVING DOLPHIN" Photographie d'un chargement antérieur. On rapporte un arrimage semblable pour ce voyage.

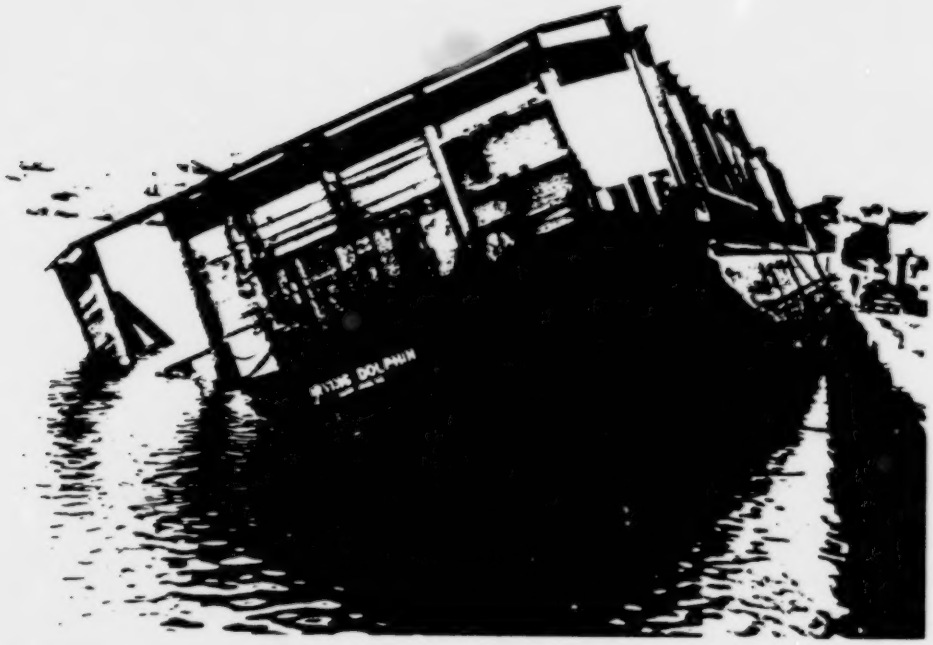
"IRVING DOLPHIN" No. 3 port tank manhole.
Note: Cover to left is from a starboard tank. Note rust spots where strongbacks rest on coaming.

Le trou d'homme de la citerne bâbord n° 3 du "IRVING DOLPHIN".
À remarquer: le bouchon sur la gauche vient d'une citerne tribord. Il y a de la rouille entre les étriers de trou d'homme et l'hiloire.



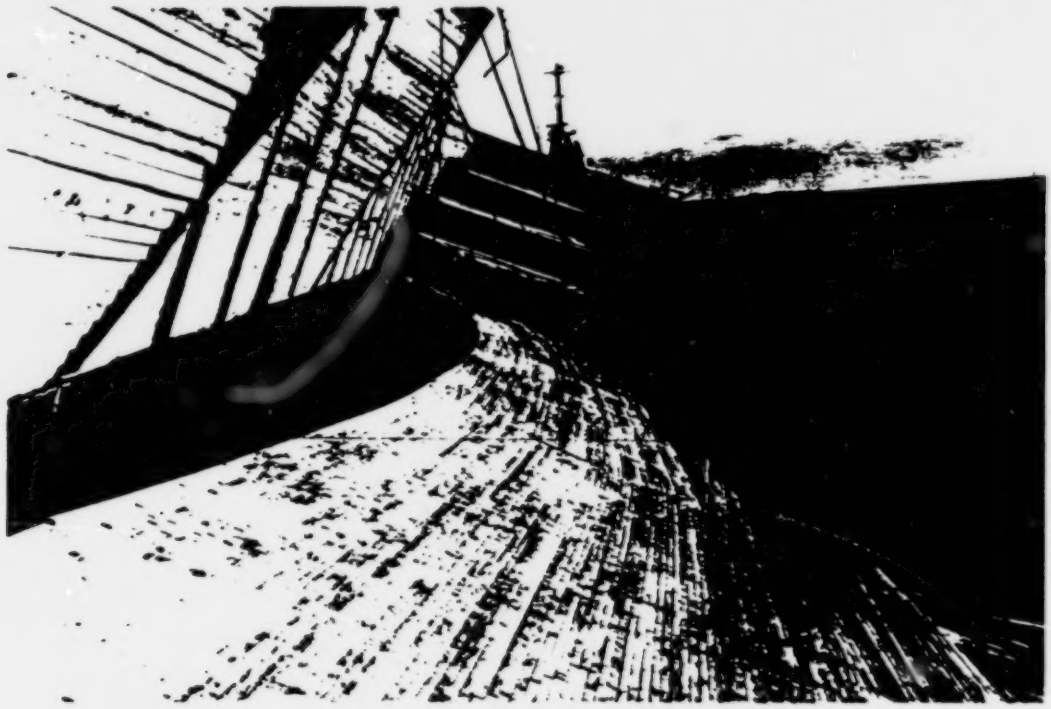
Cover to No. 3 port tank manhole.
Note: Two strongbacks fractured.

Bouchon du trou d'homme de la citerne bâbord n° 3. À remarquer: deux étriers de trou d'homme fracassés.



"IRVING DOLPHIN" on arrival at Louisbourg, N.S.

"IRVING DOLPHIN" à l'arrivée à Louisbourg (N.-E.)



"IRVING DOLPHIN" on arrival at Louisbourg, N.S.

"IRVING DOLPHIN" à l'arrivée à Louisbourg (N.-E.)